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Abstract: While Kant introduces his critical philosophy in continuity with the experimental tradition begun by Frances Bacon, it is widely accepted that his Copernican revolution places experimental physics outside the bounds of science. Yet scholars have recently contested this view. They argue that in *Critique of the Power of Judgment* Kant's engagement with the growing influence of vitalism in the 1780s leads to an account of nature's formative power that returns experimental physics within scientific parameters. Several critics are sceptical of this revised reading. They argue that Kant's third *Critique* serves precisely to deflate the epistemological status of experimental physics, thereby protecting science from the threat of vitalism. In this paper I examine Kant's account of science in the context of the experimental tradition of philosophy, particularly in relation to the generation dilemma of the eighteenth century. I argue that Kant does not deflate the epistemological status of experimental physics but rather introduces systematicity to the experimental tradition. By identifying the reflective use of reason to organize laws of experience into a systematic whole, Kant aims to ground experimental inquiry on the secure course of a science, opening a conception of science as a research program.

In the preface to the second edition of *Critique of Pure Reason* (1781/7), Kant introduces his critical project as a new development in the revolution begun by Francis Bacon's experimental science. Kant praises the 'sudden revolution in the way of thinking' (Bxii)¹ that was occasioned and stimulated by Bacon, who, by combining experimentation and reason, grounded the natural sciences on a 'secure source of a science after groping about for so many centuries' (Bxiv). He then proposes to replicate this revolution in the field of metaphysics by undertaking an 'experiment of pure reason' (Bxviii). While it has previously 'been assumed that all our cognition must conform to the objects' of inquiry, Kant's experiment aims to test the hypothesis that we might 'get further in the problems of metaphysics by assuming that the objects must conform to our cognition' (Bxvi). Thus understood, cognition would not reflect but rather legislate nature, 'framing for itself with perfect spontaneity an order of its own according to ideas, to which it adapts the empirical conditions' (A548/B576). Kant claims that this experiment will place metaphysics on 'the secure course of a science,' for it allows us to 'provide satisfactory proofs of the laws that are the *a priori* ground of nature, as the sum total of objects of experience' (Bxix).

¹ Citations to *Critique of Pure Reason* are to the customary A/B page numbers from the first and second editions. Citations to *Metaphysical Foundations of Natural Science* and *Critique of the Power of Judgment* are to Volumes 4 and 5 of *Kants gesammelte Schriften*, Akademie Ausgabe respectively. Translations are from the Cambridge University Press editions.

By applying Bacon's experimental method to the practice of metaphysics, Kant's 'revolution' has the effect of pushing the areas of Baconian inquiry that cannot be constituted *a priori* outside the bounds of legitimate science. It assigns philosophy the task of reflecting on the constitution of objects as objects of thought, thereby rejecting the talk of correspondence between representations and an independently structured reality. Experience is not the starting point of knowledge but rather the outcome. In *Metaphysical Foundations of Natural Science* (1785), Kant states that because the fields of 'experimental physics' examine chemical and organic items through examples, they cannot contain necessity and are thus 'figurative' or 'improper' sciences (*uneigentliche Wissenschaften*):

So long, therefore, as there is still for chemical actions of matters on one another no concept to be discovered that can be constructed, ... then chemistry can be nothing more than a systematic art or experimental doctrine, but never a proper science, because its principles are merely empirical, and allow of no *a priori* presentation in intuition. Consequently, they do not in the least make the principles of chemical appearances conceivable with respect to their possibility, for they are not receptive to the application of mathematics. (4:470-1)

In Kant's schema a 'proper' science requires the prior guarantee that its inquiry is such that successful answers to its questions will be forthcoming. Science is concerned with its object 'wholly according to *a priori* principles' (4:468), producing a system that encapsulates the interconnection of grounds and consequences. The boundary between proper and improper science reflects the insight that nature appears to us as an aggregate of contingent laws, or laws of experience (*Erfahrungsgesetze*). While proper science is concerned with the synthetic *a priori* principles that govern the objects of thought, improper science is concerned with dynamical laws that are synthetic and *a posteriori* (B164-165). Our experimental search for laws is 'a systematic art rather than a science' (4:468), for it discovers laws that could logically and conceptually be otherwise than they are. A 'proper' experimental science is impossible, for to know in advance that nature must be exactly as we discover it to be would require an intuition of nature as a whole, a foreknowledge that is possible for God alone.

Prima facie it seems that experimental physics plays no role in Kantian science. However, several scholars have recently argued that in *Critique of the Power of Judgment* (1790) experimental physics comes to play a vital role in the scientific endeavor for systematic knowledge. Kant's examination of the features of humans as students of nature discovers that our experimental estimation of chemical and formal causes are not mere guesswork but take the form of judgments grounded on the same principle used 'in every logic and every principle of cognitions that is not skeptical' (5:239). Philippe Hunemann ('Reflexive Judgment and Wolffian Embryology,' 85) argues that by examining our reflective capacity to discern emergent laws in terms of judgment, Kant's conception of science expands beyond that which can be constituted *a priori* to include contingent phenomena such as chemical reactions and living beings. He examines this development in terms of Kant's interaction with Casper Friedrich Wolff's vitalist program, claiming that Kant's attempt to draw out the epistemological implications of Wolff's *vis essentialis* leads to an account of nature as a self-propagating (*sich fortpflanzend*) domain that lies beyond what can be constituted by cognition. Ina Goy ('Epigenetic Theories,' 55) argues that it is Blumenbach who prompts Kant's development: Blumenbach's account of part-whole composition of living beings allows Kant to make the 'most astonishing claim' that nature must be conceived of as a formative power (*bildende Kraft*) that generates and preserves itself.

This power cannot be constituted *a priori* but nevertheless bears consciousness of necessity. Eric Watkins ('Nature in General as a System of Ends,' 117-118) observes that once we think of living beings as self-organizing we 'are necessarily led beyond this initial topic to think of nature in general,' that is, we discover a new concept of nature in which *experience* gives rise to necessity.

While Hunemann, Goy, and Watkins claim that Kant's account of a self-propagating power draws experimental physics into the domain of science, others commentators such as Robert Richards and John Zammito argue that *Critique of the Power of Judgment* serves precisely to protect his earlier conception of science against the growing influence of vitalism. For Zammito, Kant's notion of nature's self-propagation safeguards a mathematically restricted Newtonian ontology. Rather than extending science beyond that which can be constituted *a priori*, Kant's revised topography of the sciences deflates the epistemological status of the study of living things, thereby making a '*historical retreat*' in response to the vitalist attack. In this sense 'epistemological "deflation" (from "constitutive" to "regulative", that is, from explanatory to heuristic) was the decisive feature of Kant's treatment of the life sciences of his day,' for it sets 'in epistemological suspension the question of the actuality of function in biology' (Zammito, 'Teleology then and now,' 749). There is thus no way of 'reconciling biology *at all* with Kant's prescriptions for science' (Zammito, "'This Inscrutable Principle of an Original Organization",' 102). Richards ('Kant and Blumenbach on the *Bildungstrieb*,' 26) similarly concludes that the 'thought that Kant provided a conceptual framework in terms of which biological science could be conducted' is simply a 'historical misunderstanding.'

Does Kant's transcendental analysis of the practices of the students of nature draw experimental physics into the parameters of science, or does it serve to protect a Newtonian account of science against those who introduced a vital life force to scientific inquiry? To answer this question I examine Kant's response to vitalism as a part of his broader engagement with what Peter Anstey ('Bacon, Experimental Philosophy and French Enlightenment Natural History') recently termed the 'experimental tradition' of philosophy, that is, the tradition beginning with Bacon's attempt to recast natural philosophy in terms of experimentation. Kant's treatment of the idea of a vital life force can be understood as a part of a broader engagement with the experimental tradition of philosophy that takes shape in his pre-critical natural history, is checked by the critical turn, and is then reexamined transcendently in the third *Critique*. Though examining Kant's engagement with experimental philosophy, I argue that the third *Critique* does not deflate the epistemological status of experimental physics but rather introduces systematicity to the experimental tradition. By identifying the reflective use of reason to organize laws of experience into a systematic whole, Kant's third *Critique* aims to ground experimental inquiry on the secure path of science, opening transcendental philosophy to a conception of science in progress, science in the making.

Experimental philosophy

As Kant notes in the B preface of *Critique of Pure Reason*, the experimental tradition of philosophy begins with (or at least is 'further stimulated' by) Bacon's attempt to reform natural philosophy into a practical science. Bacon saw that natural philosophy was vulnerable to skeptical

attack. The coherence of philosophy's speculative investigation of causative forces with nature is grounded on the assumption that being (nature in itself) is immediately available to thought. As empirical investigative methods in natural philosophy began to challenge the coherence of natural facts and speculative system building, Bacon saw the need for an experimental program to verify philosophy's knowledge of nature. In *The Advancement of Learning* (1605) he develops a topology of knowledge that privileged empirical investigation over and against speculation. He identifies three distinct parts of learning: philosophy, history, and poesy. Each part has 'reference to the three parts of man's understanding, which is the seat of learning: history to his memory, poesy to his imagination, and philosophy to his reason' (Bacon, *Advancement of Learning*, 93). These three regions of inquiry are not isolated from each other, yet neither do they share the same level of primacy. In *Parasceve ad Historiam Naturalem et Experimentalem* (1623) Bacon (cited in Giglioni, '*Historia and Materia*,' 71) explains that natural history unveils nature so that 'streams of experiments of the mechanical arts should flood on every side into the sea of philosophy.' Natural history is the 'primary matter' or 'nursing mother' of natural philosophy (Anstey, 'Bacon, Experimental Philosophy and French Enlightenment Natural History,' 6), for natural philosophy takes place in and as a part of natural history (Anstey, 'Locke, Bacon and Natural History,' 72). It is characterized by utility, filling a storehouse of facts that provide a representation of the world that matches reality. As Giglioni ('*Historia and Materia*,' 73) explains, Bacon's concern is to ensure that the world is not 'tailored to the slenderness of the intellect (which is what has been done hitherto) but the intellect should be stretched and opened up to take in the image of the world as we really find it.'

That Bacon's attempt to ground philosophy on an experimental methodology stimulates a 'sudden revolution in the way of thinking' is evident in the revised parameters it established for both the British and French traditions of natural philosophy. As Anstey ('Locke, Bacon and Natural History,' 65) has shown, by the 1670s experimental philosophy featured as the prevailing methodological approach in the Royal Society. The work of the earliest members of the Royal Society, including Robert Boyle, Robert Hooke, Robert Plot, and John Woodward, was characterized by the wholehearted rejection of system building and the construction of a new experimental paradigm in its place (Anstey, 'D'Alembert, the 'Preliminary Discourse' and experimental philosophy', 496). By the early-eighteenth century, key members of *l'Académie Royale des Sciences* also employed an experimental research program. French natural historians built on the method and findings of the British experimental scientists to overcome the philosophical tendency to trivialize the significance of matter, thereby distinguishing experimental from speculative philosophy (Anstey, 'Bacon, Experimental Philosophy and French Enlightenment Natural History', 13).

Experimental philosophy faced a significant challenge during the mid-eighteenth century in what Hunemann ('Reflexive Judgment and Wolffian Embryology,' 78) describes as the 'generation dilemma.' The generation dilemma arose through the development of ocular technologies that enhanced the study of reproductive mechanisms of animate beings. Of particular importance were experiments conducted on the embryonic change from liquid to distinct parts in chickens' eggs (see Maupertuis, *Vénus physique* (1745), Haller, *Sur la formation du coeur dans le poulet* (1758)). With the aid of increasing microscopic power, experimental philosophers observed that the emergent parts of a

chicken do not unfold according to an internal nucleus of information that presses on inert matter. Rather, the parts are formed separately, somehow organizing themselves into a coherent whole. How is the emergence of organized form from unorganized matter to be explained? The question collapsed the distinction between experimental and natural philosophy, for the answer turns on one's understanding of what kind of forces are operative in nature. For Albrecht von Haller, the emergence of the complex organization in chicken embryos can be explained only in terms of preformationism. Preformationism entails that matter is in itself powerless. The progression of chicken's embryos from a homogenous mass to a heterogeneously structured whole is explained through reference to an artesian God, who grants to animate bodies the forces of sensibility, irritability, and contractility (Roe, *Matter, Life, and Generation*, 31). Pierre Louis Maupertuis, on the other hand, argued that generation requires secondary causes that, because God remains *outside* of time, are responsible for *natural formation* (Roger, *The Life Sciences in Eighteenth-Century French Thought*, 385). Anticipating the theory of epigenesis, Maupertuis appealed to a nutritive force characterized by a dialectical movement between fluidity and solidity. Building on Maupertuis' work, advocates of epigenesis such as Georges Buffon and John Needham claimed that organized and unorganized matter are ontologically distinct; organic items require an alternative explanatory paradigm sensitive to development.

Linnaeus and Buffon

The generation dilemma challenged the standard classificatory systems used by the leading natural historians of the mid-eighteenth century, opening the question of justification: on what grounds do we expect that our examination of nature will yield results? Carl Linnaeus (*Systema naturae*, 1735, 18), an advocate of preformationism, ground the basic principles of classification on the notion of an artesian God:

As there are no new species (1); as like always gives birth to like (2); as one in each species was at the beginning of the progeny (3); it is necessary to attribute this progenitorial unity to some Omnipotent or Omniscient Being, namely God, whose work is called *Creation*. This is confirmed by the mechanism, the laws, principles, constitutions and sensations in every living individual.

Linnaeus advanced what Paul Farber (*Finding Order in Nature*, 10) describes as an 'artificial system' of classification, which aims to reflect the balanced and harmonious creation of a Creator who shapes inert matter according to efficient laws. On this assumption his system relies on just a few characteristics inherited from Aristotle's taxonomy to categorize relations of genus and species, such as being warm- or cold-blooded and reproducing oviparously or viviparously.

From the view of epigenesis, Linnaeus' principles are wrongheaded. If organic items are shaped according secondary forces responsible for natural formation, then the task of classification is not to build an artificial system that reflects the handiwork of God, but rather to build a 'natural system' that presents relationships existent in nature (Farber, *Finding Order in Nature*, 10). That living

begins are governed by a self-directed nutritive force entails that classification must go beyond surface characteristics.

Buffon was one of the first experimental philosophers to identify the implications of epigenesis for natural history. While Bacon separated history and philosophy as two methodologically distinct areas of inquiry, Buffon denied the idea of natural history as an inventory of natural singularities to be systematized by natural historians. He aimed to transform natural history into a general science of nature by extending the objects of natural history from natural singularities to kinds, species, genera, and, more importantly, to the principles of their development (Hoquet, *Buffon: Histoire Naturelle et Philosophie*, 79). In the opening discourse of his thirty-six volume *Histoire Naturelle* (1749), Buffon criticizes the artificial system of natural history advanced by Linnaeus. If the classification of the living world is to become a science, it requires a method that does not rest on Linnaean principles. Buffon's critique of system building locates his account of natural history within experimental philosophy: 'Systems are built on uncertain facts [*des faits incertains*] that have never been examined, and which only serve to show the human penchant for wanting to find the resemblance between the most desperate objects, regularity where only variety reigns, and the order of things perceived with confusion' (Buffon, *Histoire Naturelle*, 10). Opposed to the systematic drive of speculative science, Buffon (*Histoire Naturelle*, 28) claims that 'the only true science is the knowledge of facts [*la connoissance des faits*].' Yet the 'knowledge of facts' does not entail bare items stripped from causative relations. Buffon's alternative aims to navigate two 'equally dangerous' positions: 'the first, to have no method at all, and the second, to try to bring everything into a particular system' (Buffon, *Histoire Naturelle*, 22-23). To move science from endless description on the one hand and speculative oscillation on the other, he proposes an anthropological approach that privileges usefulness: 'on the whole it is easier for us, more agreeable and more useful to consider the things in relation to us than from any other point of view' (Buffon, *Histoire Naturelle*, 34).

Buffon's anthropological approach aimed to transform the experimental tradition in the following way. Bacon originally proposed a human-centered approach to natural history. Yet he maintained a conception of nature as artifice to provide a factual basis for natural philosophy. While this method appears to solve the problem of correspondence by grounding speculation on facts, it merely *presumes* a conception of nature as artifice as a means to guarantee that commonalities express necessary laws. Dismissing this conception of nature as ungrounded, Buffon (*Histoire Naturelle*, 51-52) collapses the Baconian distinction between natural history and natural philosophy, relativizing knowledge to human beings:

Here there is a need for a new method to guide the mind, not that method of which we have already spoken [that of Linnaeus], which only serves to arrange words arbitrarily, but for a method that sustains the very order of things. ... Even in our own century, when the sciences appear to be cultivated with care, I believe that it is easy to see that philosophy is neglected, perhaps more so than in any other century. The arts we call scientific have taken its place. We pay no attention to the fact that all these arts are only the scaffolding to reach science, and not science itself.

Buffon aims to reform experimental philosophy as a science by placing methodology as its first task. This new method seeks to make us 'capable of grasping distant relationships, bringing them together,

and making out of them a body of reasoned ideas' by 'the power of analogy.' Analogical reasoning does not begin from the categories we already possess or attempt to reflect God's pre-established order. Rather, it begins from phenomena in the search for categories that form a system:

All that is possible for us is to see some particular effects, to compare them, to combine them, and finally to acknowledge therein an order relative to our own proper nature, which is adequate to the existence of the things we are considering. (Buffon, *Histoire Naturelle*, 12)

Buffon repeats the deflationary account of scientific knowledge characteristic of the experimental philosophy tradition and yet rejects the conception of nature as artifice in favor of a fallibilist approach that does not require extra-mental presumptions. His revised epistemology is grounded on a calculus of probabilities in which, as Sloan ('Kant on the history of nature,' 631) explains, the repetition of a series of experiments is 'sufficient to reveal a convergence between the empirical order of nature, revealed by observations of recurrent phenomena, and the metaphysical structure of nature itself.' Yet Sloan's characterization of Buffon's analogical method is misleading. Buffon rejects the very idea of a metaphysical structure of nature, for it retains the problem of correspondence. This is evident in his notion of the two orders of truth, abstract and physical, each of which constitutes a properly scientific area of investigation (Buffon, *Histoire Naturelle*, 53-54). On the one hand, mathematical truths (*les vérités mathématiques*) are 'the truths of definition.' They are abstract, for 'truths of this kind are simply the composed but always abstract consequences of these definitions.' Physical truths (*les vérités physiques*), on the other hand, 'are by no means arbitrary, and do not depend on us. Instead of being based on assumptions we have made, they depend on facts [*des faits*]; a sequence of similar facts, or, if you will, a frequent repetition and an uninterrupted succession of the same events.' Thus physical truths denote the knowledge produced by induction that does not *converge* with the structure of nature but rather *presents* this structure:

what is called physical truth is thus only a probability, but a probability so great that it amounts to a certainty. In mathematics, one supposes. In physics, one poses and then establishes. There, one has definitions, here, one has facts. (Buffon, *Histoire Naturelle*, 55)

Buffon frees natural history from the mathematical standard of demonstrability and proposes a realist account of nature internally justified by a calculus of probability. The result is a classificatory system that does not reflect enduring and fixed physical traits but organizes relationships according to interior moulding forces (*moule intérieur*). Interior moulds account for the capacity of living beings to both transmit heredity and to dynamically respond to changing environmental contexts. This dynamic capacity requires a non-mechanical 'penetrating force' that is conceived of by an analogy with Newtonian attraction (Buffon, *Histoire Naturelle*, 35ff). While Newtonian attraction describes the 'surface forces' that act on brute matter in a two-dimensional sense, penetrating forces act in *three* dimensions, integrating organic molecules into the living substance of organs through the interior moulds pressing on inert matter (Roger, *Buffon: A Life in Natural History*, 129). The combination of Newtonian and moulding forces requires a system of classification that makes an arrangement of species as lineages that produce fecund offspring (Hoquet, 'Buffon: From natural history to the history of nature?' 416).

Buffon's analogical method problematizes the strict boundary Bacon cast between natural history and natural philosophy. It recognizes that living beings do not reflect pre-established order but express contingent unity, meaning that the convergence of parts into whole characteristic of organic life is not mechanical but the result of an interior force. The study of contingent form is not a deficient science; Buffon rejects the ideal of mathematical demonstrability in favour of the various forms of human inquiry that actually do exist, and that exist because they give us results that we can use.

Kant's natural history

In the 1777 version of 'Of the Different Human Races,' a revised expanded version of his 1775 essay, Kant distinguishes the conventional practice of natural history from Buffon's method to highlight the superiority of the Buffonian approach to experimental science:

We commonly make no distinction between the expressions 'the description of nature' [*Naturbeschreibung*] and 'natural history' [*Naturgeschichte*]. However, it is obvious that knowledge of the things of nature as they now are will always leave us wishing for knowledge of how they once were and by what series of changes they went through to come to their present place and condition. Natural history, of which we presently have very little, would teach us about the changes of the earth's form, including that the changes that the earth's creatures (plants and animals) have sustained as a result of natural migrations, and about the deviations from the prototype of the lineal root genus [*Stammgattung*] that have originated as a consequence of these migrations. Natural history would presumably lead us back from the great number of seemingly different species [*Arten*] to races of the same genus [*Gattung*] and transform the presently overly detailed system [*weilläufige Schulsystem*] for the description of nature into a physical system for the understanding [i.e. a science]. (Kant, 'Of the Different Human Races [1777]', 13n, translation modified)

As Sloan ('Kant on the history of nature,' 635) has demonstrated, in this text Kant systematizes Buffon's contrast between 'abstract' and 'physical' arrangements. The 'description of nature' entails the empirical study and classification, moving from the whole to the parts in order to draw categorical distinctions into an 'overly detailed system.' This methodology classifies how objects appear to the observer in the present, and is thus insensitive to natural development. 'Natural history,' on the other hand, refers to an inductive method that is capable of moving from individual parts to a sense of the whole to inquire into origins and historical change. It is concerned with a teleological kind of causality, for it takes the present appearance of species as the expression of a broader structural development that promotes the self-propagation of the lineal root genus.

Kant's notion of natural history examines organic generation in terms of 'germs' (*Keime*) and 'natural predispositions' (*Anlagen*). While the dominant scientific view of Kant's time stressed the importance of environmental factors in shaping the variations among human beings, Kant sided with Buffon's research that pointed to certain hereditary characteristics that pass on traits in the context of contingent environmental factors. In the 1775 version of his essay on race Kant ('Of the Different Human Races [1775]', 49) defines *Keime* as 'the bases [*Gründe*] lying in the nature of an organic body (plant or animal) for a determinate development of the same body.' When the development concerns the relation of the parts to each other, however, he appeals to *Anlagen*. The capacity to dynamically respond to differing climates with the goal of promoting species propagation must have originally been

existent in human beings, and while subsequent generations projected themselves on this contingent line of unfolding, they lost the capacity to exist in other environments.

In his essay on race Kant is concerned with articulating how the Newtonian program can account for the diversity of living beings. Buffon's distinction between two orders of truth provided assistance, for it entails that organic life contains the capacity to dynamically respond to environmental and historical particularities whilst still adhering to natural laws. The practice of natural description, which is oblivious to *Keime* and *Anlagen*, describes empirical similarities in a way that bears no consciousness of necessity. An alternative method is required to grasp 'inner form,' thereby providing a scientific account of the constitution of living objects:

We see, then, that the description of nature (i.e. the condition of nature at the present time) does not suffice to explain the diversity of human deviations. We must, therefore, venture to offer a history of nature, even if we are also – and rightfully so – hostile to the impudence of mere opinion. This kind of history is, however, a separate special kind of science and it could well serve to move us gradually from opinions to true insights. (Kant, 'Of the Different Human Races [1777],’ 22)

Only natural history can give a scientific approach to living beings, Kant claims, for it does not simply document natural facts but accounts for the necessity of their present arrangement. From the perspective of natural description, species variation bears a merely contingent relation to its original genus. From the perspective of natural history, however, species is a dynamic appearance of a basic genus that developed from both external pressures and inner necessity.

While Kant's method for natural history builds on Buffon's penetrating forces, his conception of *Keime* departs from Buffon's interior moulds. Well before his essay on race Kant ('The Only Possible Argument in Support of a Demonstration of the Existence of God,' 1763, 157) identified a problem with Buffon's explanation of organic force in that it attempts to *explain* generation through reference to internal form:

The internal forms proposed by *Buffon*, and the elements of organic matter which, in the opinion of *Maupertuis*, join together as their memories dictate and in accordance with the laws of desire and aversion, are either as incomprehensible as the thing itself, or they are entirely arbitrary inventions.

While Kant acknowledged that we require some notion of 'internal forms' to account for organic matter, the accounts provided by Buffon and Maupertuis simply replace the Linnaean divine artificer with an equally ungrounded *explanans* for the existence of living form (see Fisher, 'Metaphysics and Physiology in Kant's Attitude towards Theories of Preformation,' 34). Kant does not side with the vitalist alternative advocated by Herder, however, which replaces moulds with a self-organizing vital force. In his 1785 review of *Ideas for a Philosophy of the History of Humanity* (1784-1785), Kant argues against Herder's vitalist account of force by repeating the argumentative strategy he used against Buffon. Herder's 'hypothesis of invisible forces' (his account of an 'organic force') simply attempts to 'explain *what is not understood* in terms of *what is understood even less*' (Kant, 'Reviews of Herder's Ideas,' 209). Kant's experiment in *Critique of Pure Reason* serves to prove that cognition *produces* experience; experience itself cannot yield knowledge. By submitting metaphysics to the deflationary method of the experimental tradition, Kant reduces the classification to a contingent

practice. This builds on his critique of Buffon, for it shows, against Herder, that our understanding of inner form does not yield knowledge. Yet it also opens the corresponding problem of how living beings can be explained at all. If living beings cannot be explained as artifacts shaped by efficient laws, how is experience of them possible at all?

Reason's regulative use

Several scholars have accounted for Kant's Copernican revolution as a break from Buffonian natural history and, more specifically, from Buffon's account of living beings according to interior forces. Zammito (*The Genesis of Kant's Critique of Judgment*, 191) describes Buffon's impact in terms of a 'generational shift' from the Newtonian inspired experimental philosophy to the new epigenetic approach to organic generation in French empirical sciences. While this generational shift had a marked impact on the German tradition in the 1770s and 80s in the work of Herder, Blumenbach, and Wolff, Zammito claims that Kant 'never achieved any sympathy for the problems or insights of the new approach,' for he was 'set in the thought patterns, the paradigm, of the earlier period.' It was to protect the proper scientific approach that Kant took up the question of methodology for the life sciences in *Metaphysical Foundations* and *Critique of the Power of Judgment*; he aimed to 'correct their derivations from the authentic scientific approach' in order to 'uphold the letter of the Newtonian law.' Zammito ('Teleology Then and Now,' 766) claims that it was against philosophers such as Blumenbach who searched for a non-mechanical formative drive that Kant retreats to a 'foundationalist' account of Newtonian physics. The third *Critique* is thus motivated by a paradoxical impulse: even though Kant realized that the mechanical account of causality 'would not work in the case of organic life,' he comes up with an elaborate system that allows him to maintain it nonetheless.

Zammito is correct to note that the revolution in metaphysics Kant proposes in *Critique of Pure Reason* reduces the scope of natural history outlined in his pre-critical work. Yet this revolution does not *break* from natural history. It rather steps back from a historical method in order to inquire into the limits and possibility of the experimental project. On one level this move is in fact continuous with the experimental tradition. As the experimental philosophers demonstrated by placing experimental methodology over and against speculation, Kant recognized that ontology fails to meet the standards of a science, for it cannot defend its claims before the tribunal of reason. Yet against the experimental program, Kant recognized that ontology could not be grounded on natural history. In a move that reflects Buffon's revolutionary take on experimental philosophy, Kant argues that nature does not exist as a set of facts awaiting our classification. Yet Kant rejects Buffon's revised version of natural facts, which replaces the mathematical ideal of the system for a method grounded on probability and tailored to human use. For Kant, this version fails to avoid the initial problem of realism that remained in Baconian science: it cannot guarantee that its experimental research will, to use Plato's metaphor, carve nature at its joints. Without the systematic expectation that our inquiry poses the right questions to nature, it is only *with luck* that a realist method discloses nature's order. Kant's alternative is not to suggest a new or revised method but rather to examine the transcendental justification for any methodology; he examines how we are entitled to assume that there *are* joints.

To demonstrate this entitlement, Kant examines cognition in terms of the understanding, which he represents as the ‘capacity to judge’ (*Vermögen zu urteilen*) (A69/B94). The understanding spontaneously produces rule-governed combinations of representations, making it possible for us to recognize the numerical identity of individual objects through time and to subsume empirical objects under concepts of natural kinds. Such judgments are both synthetic and *a priori*: they combine intuitive content with conceptual form, thus providing new information that is necessarily true. Proper science is the study of those categories according to which our representation of the numerical identity of objects, and our capacity to reflect them under concepts, is possible. Kant’s transcendental method aims to demonstrate that these categories are necessary for any representation of an object.

Given that Kant’s primary concern is the justification of synthetic *a priori* judgments, the task of finding laws for new items we encounter seems to lie outside the domain of science. If no law is given, such judgments are synthetic and *a posteriori* and thus bear no consciousness of necessity. However, once he is finished exposing the fallacious use of reason by speculative scientific systems, Kant identifies in the Appendix to the Transcendental Dialectic the ‘excellent, and indeed indispensably necessary, regulative employment’ (A644/B672) of the principles of pure reason. His notion of the *regulative* employment of the principles of reason grants the laws of experience *some* role in the system of knowledge, for it demonstrates how reason ‘prescribes’ and ‘seeks to bring about’ the ‘systematic in cognition,’ transforming our knowledge from a ‘mere aggregate’ to ‘a system connected according to necessary laws’ (A645/B673). Through the pursuit of unity guided by the regulative use of reason, we can forge principles that count as ‘laws’ that express ‘necessity.’² Kant argues that we can see this regulative use of reason in ‘the classifications of the students of nature’ (A646/B674). Here Kant is not concerned with taking sides on classificatory systems but with establishing that the classificatory project itself brings ‘unity into particular cognitions as far as possible and thereby approximating the rule to universality’ (A647/B675). Kant links theoretical unification with empirical confirmation, and shows that the pursuit of the latter makes sense only within the context of the former.

Kant’s account of the regulative deployment of reason is underdeveloped in his first *Critique*. The very notion of ‘approximating the rule to universality’ seems contradictory to one of the text’s guiding threads: that concepts without instances cannot be legitimated. Such approximation remains separate from judgment, and thus does not identify how our observation of new items of inquiry could bear necessity. Yet Kant’s idea of the regulative use of reason in *Critique of Pure Reason* is not his final word on the matter. As he makes clear in the First Introduction of *Critique of the Power of Judgment*, one of the key aims of his third installment in the critical project is to reexamine the *capacity* to judge in terms of the *power* of judgment (*Urteilstkraft*). The power of judgment, as Béatrice Longuenesse (*Kant on the Human Standpoint*, 18) states, is the actualization of judgment under sensory stimulation; precisely what we find expressed in the ‘classifications of the students of nature.’ In his analysis of judgment’s sensory employment Kant discovers not one but *two* judicial forms. In contexts in which we already possess the rule, we judge determinatively by subsuming given appearances under

² Kant notes in the Second Analogy that there are arguments for the principles about the lawfulness of nature and the subordination of all events to causal laws. Yet, as Philip Kitcher notes, these discussions contain no hint that some “regulative use of reason” is needed to confer lawlike status upon a principle. See Kitcher, “Projecting the Order of Nature,” 209.

categories. When we encounter particular items for which we much search for the rule under which they fall, however, we judge reflectively. Here Kant does not repeat his account of regulative approximation. He instead examines the power of *judgment* to find empirical concepts and to place them within the system of knowledge:

The understanding is of course in possession *a priori* of universal laws of nature, without which nature could not be an object of experience at all; but still it requires in addition a certain order of nature in its particular rules, which can only be known to it empirically and which from its point of view are contingent. (5:184)

The separation of determinative and reflective judgment reflects the constitutive/regulative distinction of the first *Critique*. The laws of experience are not synthetic and *a priori*, and thus do not constitute the field of experience. Rather, they regulate our reflection on nature as a system. Because the regulative ideal of reason requires us to systematize the body of our beliefs, we come to credit some statements with a necessary status by virtue of their incorporation in a system that is constructed by following certain rules that *are* necessary. Kant states that we consider such statements ‘as rules, (i.e., as necessary), because otherwise they would not constitute an order of nature, even though it does not and never can cognize their necessity’ (5:185).

Kant elucidates this process by showing how art can become a science. Discovering the laws of experience is ‘the art [*Kunst*] or science [*Wissenschaft*] of bringing under rules the reciprocal relation of the understanding and the imagination to each other in the given representation’ (5:286). This investigation is merely an art ‘if it shows this only in examples.’ Without a governing principle of unity, the investigation of nature as art has no guarantee that our research will yield the intended results. The investigation becomes a science, however, ‘if it derives the possibility of such a judging from the nature of this faculty as a faculty of cognition in general.’ Kant’s transcendental endeavor in the third *Critique* is to show that while experimental physics does not yield a system of synthetic and *a priori* principles, it nevertheless constitutes a ‘rational science’ to the extent that the *investigation* into contingent rules is governed by an *a priori* principle, and thus entails a claim to necessity. Kant argues that this principle is already (albeit implicitly) at work in the propositions of experimental physicists who make such claims as, ‘there is in nature a subordination of genera and species that we can grasp,’ or, species ‘converge in accordance with a common principle’ (5:185). Classification is possible only on the grounds of our regulative expectation that nature arranges itself according to a system.

To demonstrate how we are entitled to presume the possibility of integrating our discoveries of facts into a unified system, Kant introduces the notion of ‘purposiveness’ (*Zweckmäßigkeit*). This notion of purpose is not a matter of constitutive experience. Rather, Kant argues that *human cognition* is purposive to the extent that it is governed by a teleological principle in any scientific inquiry. The first task of an experimental science is thus to establish a principle guaranteeing that

for all things in nature empirically determinate concepts can be found, which is to say the same as that in all of its products one can always presuppose a form that is possible for general laws cognizable by us. For if we could not presuppose this and did not ground our treatment of empirical representations on this principle, then all reflection would become arbitrary and blind, and hence would be undertaken without any well-grounded expectation of its agreement with nature. (20:210-211).

Instead of maintaining a purely legislative account of scientific cognition, Kant outlines a method in which human inquiry can first presume and then search for an order that was somehow already available for comprehension. To begin any experimental inquiry into natural laws we must presume that nature contains ‘a certain economy suitable to our power of judgment and a uniformity that we can grasp, and this presupposition, as an *a priori* principle of the power of judgment, must precede all comparison’ (20:213). Kant informs us experimental inquiry is possible on the basis that ‘the power of judgment itself makes the technique of nature [*Technik der Natur*] into the principle of its reflection *a priori*’ (20:214). This principle enables judgment to proceed ‘not schematically, but technically [*technisch*], not as it were merely mechanically, like an instrument, but artistically [*künstlich*], in accordance with the general but at the same time indeterminate principle of a purposive arrangement of nature in a system.’ The archetype of this kind of inquiry is Linnaeus: ‘Could Linnaeus have hoped to outline a system of nature if ... all he could hope to find were always individual things, as it were isolated for the understanding, and never a class of them that could be brought under the concepts of genus and species[?]’ (20:216n). Here Kant seems to endorse the Linnaean project with the added caveat that the imputation of purposiveness to nature is possible on epistemic rather than ontological grounds. While Linnaeus relied on principles derived from the divine artificer, Kant claims that it is only on transcendental grounds that we can be certain that nature is intelligible to human cognition. The epistemic principle of purposiveness satisfies our rational need for assurance that the conditions of its employment can be satisfied. This assurance is grounded on a conception of nature not simply as a nexus of effective causes but also as a work of art. This is to say that the classification of nature is ‘not a common experiential cognition [*keine gemeine Erfahrungserkenntnis*]’ (20:215); our observation of nature does not spontaneously classify genus and species. Rather, classification is an ‘artistic’ (*künstlich*) cognition, meaning that the classification of nature is the achievement of research.

Experiential physics as science

We are now ready to answer at least part of our original question of the role of experimental physics in Kant’s account of science. In *Metaphysical Foundations*, Kant states that natural science is either a ‘*properly or improperly* so-called natural science, where the first treats its object wholly according to *a priori* principles, the second according to laws of experience’ (4:468). Laws of experience fail to constitute proper science, for ‘they carry with them no consciousness of their necessity [*so führen sie kein Bewußtsein ihrer Notwendigkeit bei sich*].’ In *Critique of the Power of Judgment*, Kant’s examination of the justification for experimental science discovered two ways in which the power of judgment proceeds reflectively according to an *a priori* principle of purposiveness. The purposiveness expressed in natural description grounds the presumption that nature is made for our understanding and can therefore classify and name things. The regulative use of reason requires that we draw the laws of experience into a unified system, meaning that we are entitled to view such laws as necessary insofar as they are requisite for the intelligibility of nature as a whole. Thus Kant’s examination of experimental physics turns his critical project toward what Robert Butts (‘Teleology

and Scientific Method in Kant's *Critique of Judgment*, 5) describes as 'science, not as a finished system, but as a research program.'

While Kant includes experimental practices within the scope of science by opening his account of science to include research, it seems that the experimental practices it permits are limited to a conception of nature as artifice (what Kant calls *Technik der Natur* in the First Introduction (20:215)). His account of the principle of purposiveness, which justifies our expectation that natural facts feature as the part of an explainable whole, reflects the model developed by Linnaeus, for it allows us to presume that natural products are made for our understanding and can therefore classify and name things. Thus it seems that Zammito's representation of Kant is correct: Kant shows that our experience of dynamical laws can be grafted into science at the expense of rejecting the penetrating forces introduced by Buffon and developed by Herder and the vitalists.

Yet Kant identifies a *second* ground for the purposiveness of cognition by claiming that we have experience of a particular item of experience that bears its own necessity: living beings. This kind of purposiveness is not technical (*technisch*) or artistic (*künstlich*) but organic (*organisch*), for it is grounded on the presumption that natural products are *self-organizing*. When viewed as artistic products, natural deviations are contingent, for we can easily imagine situations in which they could have been otherwise (5:360). They make no sense in the Linnaean system. When viewed as self-organizing systems, however, such deviations are necessary for self-preservation:

nature ... organises itself, and in every species of its organized products, of course in accordance with some example in the whole, but also with appropriate deviations, which are required in the circumstances for self-preservation. (5:374)

On the grounds of the principle of organic purposiveness we judge the characteristics that are specific to a species and any evolved characteristics to be self-preserving, suitable for the maintenance of life. Yet whence this principle? The principle of organic purposiveness cannot be derived from a conception of nature as 'an *analogue of art*' (5:374), Kant explains, where external forces give shape to inert matter. Rather, it must be based on a conception of nature as 'an *analogue of life*,' where a locus of agency is responsible for self-directed behaviour. Of course, Kant notes that this analogy can lead to theoretical problems, for one must either 'endow matter as mere matter with a property (hylozoism) that contradicts its essence, or else associate with it an alien principle standing in communication with it (a soul).' The former move violates the separation of matter from form, the latter merely returns to a conception of nature as artifice. For Kant, neither move provides a satisfying account of the causality of items that are experienced as internally purposive. Thus he concludes that organization is not a constitutive concept of the understanding but rather a 'regulative concept for the reflecting power of judgment, for guiding research into objects of this kind and thinking over their highest ground in accordance with a remote analogy with our own causality in accordance with ends' (5:375). On the grounds of this analogy we consider a natural product as a 'natural end' (*Naturzweck*), an organized system that

produces the other parts (consequently each produces the others reciprocally), which cannot be the case in any instrument of art, but only of nature, which provides all the matter for

instruments (even those in art): only then and on that account can such a product, as an *organized* and *self-organizing* being, be called a *natural end*. (5:374)

The principle of organic purposiveness guides natural historians to classify organisms not according to their similar manifest properties but according to their similar self-preserving properties. As Butts ('Teleology and Scientific Method in Kant's *Critique of Judgment*,' 8) explains, this classificatory method allows for 'a simplification of a great deal of variety and diversity of forms, and many noted *affinities* between forms.' If we tried to examine living beings on the level of Newtonian causes we would miss these affinities; we would find a mere aggregate of parts with no necessary relation. When examined in the context of a self-organising system, we can explain the arrangement of the parts according to the whole. Kant argues that this part-whole relation is grounded on the presumption of a non-Newtonian internal force:

An organized being is thus not a mere machine, for that has only a *motive* power [*bewegende Kraft*], while the organized being possesses in itself a *formative* power [*bildende Kraft*], and indeed one that it communicates to the matter, which does not have it (it organizes the latter): thus it has a self-propagating [*sich fortpflanzend*] formative power, which cannot be explained through the capacity for movement alone (that is, mechanism). (5:374)

While Kant acknowledges that all objects have a motive power, he also claims that organized beings are distinct from machines to the extent that their necessary unity can only be explained by a formative, self-propagating power. This formative power is communicated by an organized being to materials, which do not have such a power, thereby producing organization. It denotes what Goy ('Epigenetic Theories,' 56) calls a 'self-explanatory and self-evident basic power' that cannot lead back to another condition of entailment, for it 'brings about an end as its effect and generates order among the means to achieve this end.'

Kant's account of the formative power builds on Blumenbach's notion of the *Bildungstrieb* (see §81). Blumenbach's *Bildungstrieb* does not – at least in Kant's reading – entail an actual purposive force operative in nature, but rather a rational assumption that grounds our experience of organic items. Kant's inclusion of analogical reasoning draws from Herder's notion of analogy, which allows for the rational confirmation of a relation. Yet Kant's transcendental method leads him to reject Herder's account in favour of Blumenbach's epistemological conception of the formative drive, for Herder could not provide confirmation of the vital force's determinate content. For Richards ('Kant and Blumenbach on the *Bildungstrieb*,' 32) and Zammito (*The Genesis of Kant's Critique of Judgment*, 93), Kant's account is ultimately at odds with Blumenbach, for Blumenbach clearly dismissed Kant's idea of *Keime* in the 1789 version of *Über den Bildungstrieb*. Noting the existence of cross-breed plant species and self-restoring polyps, Blumenbach (*An Essay on Generation*, 20) concludes that 'there is no such thing in nature, as pre-existing organized germs [*Keime*].' However, when he rejects the notion of *Keime*, Blumenbach's aim is not specifically against Kant but against ovist and animalculist forms of preformationism, which used *Keime* to explain reproduction by identifying lines of inherited characteristics from a single parent (Goy, 'Epigenetic Theories,' 43). When Kant takes up Blumenbach's notion of the *Bildungstrieb* in the third *Critique*, he likewise attacks these accounts of

generation, which he describes as ‘individual preformationism.’³ By rejecting both hylozoism *and* individual preformationism, Kant requires an alternate scientific approach to contingent forces.

Kant turns to Blumenbach precisely to find a third way between preformationism and hylozoism that could provide an account of organic life without claiming knowledge of vital forces. Having rejected individual preformationism, Kant proposes a conception of ‘generic preformationism,’ which he claims to be the doctrine of epigenesis properly understood (5:424). Some commentators have argued that Kant’s topology of preformationism is confused, for it fails to register epigenesis as an alternative to a mechanical conception of nature.⁴ Yet this argument misses Kant’s point: preformation and epigenesis require each other. Kant praises Blumenbach precisely for showing though his account of the *Bildungstrieb* that it is ‘contrary to reason’ to suppose that ‘matter should have been able to assemble itself into the form of a self-preserving purposiveness by itself’ (5:424). In a letter to Blumenbach written just after the publication of the third *Critique*, Kant again praises his ability to ‘unite two principles – the physical-mechanical and the sheerly teleological mode of explanation of organized nature.’⁵ Kant found in Blumenbach’s work a way to explain the self-organization of living beings within the bounds of experimental physics, that is, without transgressing the limits of experience. While Zammito claims that Kant’s account of generation is a historical retreat, for Blumenbach’s *Bildungstrieb* had outstripped the notion of *Keime* by the 1780s, neither Kant nor Blumenbach saw these explanatory concepts as incompatible.⁶ As Kant discovered in Buffon’s work during the 1770s, both preformation and epigenesis are needed to explain organic life: epigenesis provides an account of how organisms dynamically respond to their environments, preformation establishes the limits for the inquiry. This certainly fits with Blumenbach’s account of epigenesis, which does not claim knowledge of an essential force but rather presents the *Bildungstieb*, like Newton’s conception of gravity, as a *qualitas occulta* that is deducible only from its effects.⁷

Zammito (“‘This Inscrutable *Principle* of an Original *Organization*’,” 80) is correct to argue that Kant’s work was intentionally ‘anti-hylozoism.’ Yet Kant’s engagement with Blumenbach

³ In §81, Kant praises Blumenbach for both promoting and limiting the notion of a living, formative principle: “No one has done more for the proof of this theory of epigenesis as well as the establishment of the proper principles of its application, partly by limiting an excessively presumptuous use of it, than Privy Councilor Blumenbach” (5:424).

⁴ For example, Sloan argues that Kant’s concession to Blumenbach’s *Bildungstrieb* signals his rejection of the preformationist conception of *Keime* and *Anlagen* in favor of “purposive predispositions” (*zweckmässige Anlage*). Sloan, “Preforming the Categories,” 253. Richards also argues that Kant’s typology shows that he misunderstands Blumenbach. Richards, “Kant and Blumenbach on the *Bildungstrieb*,” 32.

⁵ Immanuel Kant to Johann Friedrich Blumenbach (5 August 1790), in Richards, “Kant and Blumenbach on the *Bildungstrieb*,” 11.

⁶ That Kant and Blumenbach saw their theories of generation as compatible is evident in their reactions to Christoph Girtanner’s *Über das Kantische Prinzip für die Naturgeschichte* (1796). In his book, Girtanner presents Kant’s philosophy of science as a research program for the life sciences that builds on Blumenbach’s *Bildungstrieb*. Kant praised Girtanner’s book in *Anthropology*, and Blumenbach affirmed the project in the 1807 version of *Handbuch der Naturgeschichte*.

⁷ “It is to be hoped, that there is no necessity for reminding the reader, that the expression Formative Nisus, like that of Attraction serves only to denote a power, whose constant operation is known from experience, but whose cause, like the causes of most of the qualities of matter, is a *qualitas occulta* to us. ... the great merit in the study of these powers, is to ascertain more accurately their effects, and to reduce them under general laws.” Blumenbach, *On Generation*, 20-22. See Bernasconi, “Kant and Blumenbach’s Polyps,” 76.

provides evidence against Zammito's representation of Kant's project as a historical retreat. Drawing from the topography of experimental philosophy, Kant's engagement with the generation dilemma brings to philosophy's attention a conception of what Butts ('Teleology and Scientific Method in Kant's *Critique of Judgment*,' 1) describes as 'science in the making, science as investigation.' Of course, this science does not meet the standards of the proper science of *Metaphysical Foundations*, for we cannot have prior knowledge of the laws we discover. Yet neither is it simply an improper natural science, for our discovery of these laws entails consciousness of necessity. In §61 of the third *Critique*, Kant distinguishes nature as 'the sum of the objects of the senses' (*Naturwissenschaft*) from the 'idea of nature as a system according to the rule of purposes' (*Naturlehre*), and grants to natural history the distinguished status of the second perspective (Sloan, 'Kant on the history of nature,' 642). This new conception of science as a doctrine or theory of nature can be understood in light of Kant's two notions of purposiveness: artistic purposiveness entails that the investigation of contingent rules is governed by an *a priori* principle that justifies our systematisation of the laws of experience, organic purposiveness entails that our experience of natural ends is governed by an *a priori* principle that justifies us in attributing necessity to the organization of the parts. Such a science is not proper but rational, for it demonstrates how the regulative use of reason of the first *Critique* is integrated into our empirical examination of natural kinds. In the project of rational science the observer searches for laws of experience under the guiding systematic presumption that natural products are amenable to the application of rules, and for genus and species under the presumption that living beings share inner principles of self-organization. This project is neither a historical retreat nor an epistemological deflation; it rather systematizes the experimental tradition, which had already gone to significant lengths to place natural philosophy on secure course of a science.

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